Amendments to the Claims

The listing of claims will replace all prior versions, and listings of claims in the application.

1. (Original) An adjustable phase shifter formed on a substrate, comprising:

a conductor line on the substrate that includes a first conductive segment and a second conductive segment;

a thin film of nanowires formed on the substrate in electrical contact with said first conductive segment and said second conductive segment; and

a plurality of gate contacts in electrical contact with said thin film of nanowires and positioned between said first conductive segment and said second conductive segment;

wherein a phase of an electrical signal transmitted through said conductor line is adjusted by changing a voltage applied to at least one gate contact of the plurality of gate contacts.

2. (Original) The adjustable phase shifter of claim 1, wherein said nanowires are aligned so that their long axes are substantially parallel.

3. (Original) The adjustable phase shifter of claim 2, wherein said nanowires are aligned approximately parallel to an axis between said first conductive segment and said second conductive segment.

4. (Original) The adjustable phase shifter of claim 1, wherein said nanowires are randomly aligned.

5. (Original) The adjustable phase shifter of claim 1, wherein said nanowires each have a length approximately equal to a distance between said first conductive segment and said second conductive segment.

6. (Original) The adjustable phase shifter of claim 1, wherein at least a subset of said nanowires are coated with a dielectric material to thereby form a gate dielectric.

7. (Original) The adjustable phase shifter of claim 1, wherein said thin film of nanowires forms a channel of a P-N-P transistor between said first conductive segment and said second conductive segment.

8. (Original) The adjustable phase shifter of claim 1, wherein said thin film of nanowires forms a channel of a N-P-N transistor between said first conductive segment and said second conductive segment.

9. (Original) The adjustable phase shifter of claim 1, wherein said nanowires are N-doped.

10. (Previously Presented) The adjustable phase shifter of claim 1, wherein said nanowires are doped.

11. (Original) A method of forming an adjustable phase shifter on a substrate, comprising:

(a) forming a conductor line on the substrate, wherein the conductor line includes a first conductive segment and a second conductive segment;

(b) forming a thin film of nanowires on the substrate in electrical contact with the first conductive segment and the second conductive segment; and

(c) forming a plurality of gate contacts to be in electrical contact with the thin film of nanowires and positioned between the first conductive segment and the second conductive segment;

wherein a phase of an electrical signal transmitted through the conductor line is adjusted by changing a voltage applied to at least one gate contact of the plurality of gate contacts.

12. (Original) The method of claim 11, wherein step (b) comprises:
aligning the nanowires so that their long axes are substantially parallel.

13. (Original) The method of claim 12, wherein said aligning step comprises:
aligning the nanowires approximately parallel to an axis between the first conductive segment and the second conductive segment.

14. (Original) The method of claim 11, wherein step (b) comprises:
allowing the nanowires to be randomly aligned.

15. (Original) The method of claim 11, further comprising:
forming the nanowires to each have a length approximately equal to a distance between the first conductive segment and the second conductive segment.

16. (Original) The method of claim 11, further comprising:
coating the nanowires with a dielectric material to form a gate dielectric.

17. (Original) The method of claim 11, further comprising:
doping the nanowires with an N-type dopant.

18. (Original) The method of claim 11, further comprising:
doping the nanowires with a P-type dopant.

19. (Original) The method of claim 11, wherein step (c) comprises:
forming the plurality of gate contacts on the thin film of nanowires.

20. (Original) The method of claim 11, wherein step (c) comprises:
forming the plurality of gate contacts on the substrate; and
wherein step (b) comprises:
forming the thin film of nanowires on the plurality of gate contacts.

21. (Original) A radio frequency identification (RFID) tag, comprising:
an antenna;
a beam-steering array that includes a plurality of tunable elements, each tunable element including:
a plurality of phase-adjustment components;
a switch corresponding to each phase-adjustment component, said switch including a transistor formed by a thin film of nanowires in electrical contact with source and drain contacts;
wherein said switch enables said corresponding phase-adjustment component to change a phase of said tunable element;
wherein an electromagnetic (EM) signal transmitted by said antenna is redirected by said beam-steering array.

22. (Original) The RFID tag of claim 21, wherein said beam-steering array focuses said EM signal.

23. (Original) The RFID tag of claim 21, wherein said each phase-adjustment element comprises an inductor.

24. (Original) The RFID tag of claim 23, wherein said inductor is a micro-strip inductor.

25. (Original) The RFID tag of claim 21, wherein said each phase-adjustment element comprises a capacitor.

26. (Original) The RFID tag of claim 21, wherein said nanowires are aligned substantially parallel to their long axis.

27. (Original) The RFID tag of claim 21, wherein said nanowires are randomly aligned.

28. (Original) The RFID tag of claim 21, wherein said nanowires are coated with a dielectric material to thereby form a gate dielectric.

29. (Original) The RFID tag of claim 21, wherein said nanowires have doped cores.

30. (Original) The RFID tag of claim 21, wherein said nanowires have doped shells.

31. (Original) The RFID tag of claim 21, wherein said nanowires have doped cores and shells.

32. (Original) The RFID tag of claim 21, wherein said nanowires are N-doped.

33. (Original) The RFID tag of claim 21, wherein said nanowires are P-doped.

34. (Original) The RFID tag of claim 21, wherein said beam-steering array is a beam-steering reflector, wherein said tunable elements are tunable cells that are co-planar.

35. (Original) The RFID tag of claim 34, wherein each tunable cell comprises a resonant structure.

36. (Original) The RFID tag of claim 35, wherein said switch enables the electrical coupling of said corresponding phase adjustment component to said resonant structure to change a phase of said tunable cell.

37. (Original) The RFID tag of claim 36, wherein each said resonant structure comprises:

a first electrically conductive layer;

a second electrically conductive layer;

a dielectric layer between said first and said second electrically conductive layers; and

an electrically conductive via through said dielectric layer having a first end coupled to said first electrically conductive layer and having a second end extending through an opening in said second electrically conductive layer.

38. (Original) The RFID tag of claim 37, wherein said nanowire film-based transistor is attached to said second electrically conductive layer, wherein a terminal of said nanowire film-based transistor is coupled to said second end of said electrically conductive via.

39. (Original) A radio frequency identification (RFID) tag, comprising:

a beam-steering array that includes a plurality of tunable antenna elements, each tunable antenna element including:

a plurality of phase-adjustment components;

a switch corresponding to each phase-adjustment component, said switch including a transistor formed by a thin film of nanowires in electrical contact with source and drain contacts;

wherein said switch enables said corresponding phase-adjustment component to change a phase of said tunable antenna element;

wherein an electromagnetic (EM) signal transmitted by said beam-steering array is directed by controlling the phase of each of said plurality of tunable antenna elements.

40. (Original) The RFID tag of claim 39, wherein said tunable elements are tunable transmission line segments.

41. (Original) The RFID tag of claim 40, wherein said switch shorts said transmission line segment to change a length of said transmission line segment to change a phase of said transmission line segment.

42. (Original) A method for steering an electromagnetic (EM) signal related to a radio frequency identification (RFID) tag, comprising:

(a) receiving the EM signal at a beam-steering array of the RFID tag, wherein the beam-steering array includes a plurality of tunable elements; and

(b) adjusting a phase of a tunable element of the beam-steering array to re-direct the EM signal, including the step of:

(1) actuating a switch corresponding to a phase-adjustment component coupled to the tunable element to change a phase of the tunable element, the switch including a transistor formed by a thin film of nanowires in electrical contact with source and drain contacts.

43. (Original) The method of claim 42, further comprising:

(c) prior to step (a), transmitting the EM signal from an antenna of the RFID tag;

wherein step (a) comprises receiving the EM signal from the antenna.

44. (Original) The method of claim 43, wherein step (b) comprises:
re-directing the EM signal towards a reader.

45. (Original) The method of claim 43, wherein step (a) comprises:
receiving the EM signal from a reader.

46. (Original) The method of claim 45, further comprising:

(c) scanning the beam-steering array to determine a direction from which the EM signal is received.

47. (Original) The method of claim 46, wherein step (c) comprises the steps of:

(1) performing step (b) for at least one tunable element of the beam-steering array;

(2) measuring an amplitude of the received EM signal;

(3) comparing the measured amplitude with a previously measured amplitude;

(4) repeating steps (1)-(3) until a maximum measured amplitude is determined.

48. (Original) The method of claim 46, wherein step (b) comprises:

re-directing the EM signal towards an antenna of the tag.

49. (Original) The method of claim 42, wherein step (b) comprises:

focusing the EM signal.

50. (Original) The method of claim 42, wherein step (b) comprises:

spreading the EM signal.

51. (Original) The method of claim 42, wherein each phase-adjustment element comprises an inductor, wherein said actuating step comprises:

actuating the switch corresponding to the inductor coupled to the tunable element to change a phase of the tunable element.

52. (Original) The method of claim 42, wherein each phase-adjustment element comprises an capacitor, wherein said actuating step comprises:

actuating the switch corresponding to the capacitor coupled to the tunable element to change a phase of the tunable element.

53. (Original) The method of claim 42, wherein the beam-steering array is a beam-steering reflector, wherein the tunable elements are co-planar tunable cells comprising a resonant structure, wherein step (1) comprises:

actuating a switch corresponding to a phase-adjustment component coupled to the resonant structure to change a phase of the resonant structure.

54. (Original) A method for steering an electromagnetic (EM) signal related to a radio frequency identification (RFID) tag, comprising:

(a) transmitting the EM signal using a beam-steering array of the RFID tag, wherein the beam-steering array includes a plurality of tunable antenna elements; and

(b) adjusting a phase of a tunable antenna element of the beam-steering array to re-direct the EM signal, including the step of:

(1) actuating a switch corresponding to a phase-adjustment component coupled to the tunable antenna element to change a phase of the tunable element, the switch including a transistor formed by a thin film of nanowires in electrical contact with source and drain contacts.

55. (Original) The method of claim 54, wherein the tunable elements are tunable transmission line segments, wherein step (1) comprises:

actuating a switch corresponding to a phase-adjustment component to short the transmission line segment to change a length of the transmission line segment to change a phase of the transmission line segment.

56. (Original) An apparatus for providing acoustic cancellation, comprising:

a substrate;

a plurality of acoustic cancellation cells formed in an array on a surface of said substrate, each acoustic cancellation cell of said plurality of acoustic cancellation cells including:

an acoustic antenna that receives a first acoustic signal;

a processor that processes the received first acoustic signal, and generates a corresponding cancellation control signal;

a transistor that includes a thin film of nanowires, wherein said thin film of nanowires is in electrical contact with a drain contact and a source contact of said transistor, wherein a gate contact of said transistor is coupled to said cancellation control signal; and

an actuator coupled to said transistor, wherein said transistor causes said actuator to output a second acoustic signal according to said cancellation control signal;

wherein said second acoustic signal substantially cancels said first acoustic signal.

57. (Original) The apparatus of claim 56, wherein the substrate is flexible.

58. (Original) The apparatus of claim 56, wherein said each acoustic cancellation cell further comprises:

an amplifier for amplifying said cancellation control signal

59. (Original) The apparatus of claim 56, wherein said actuator comprises:

an audio speaker.

60. (Original) The apparatus of claim 56, wherein said actuator comprises:

a thin film of piezoelectric nanowires.

61. (Original) The apparatus of claim 60, wherein said transistor allows a current to flow through said thin film of piezoelectric nanowires to generate said second acoustic signal.

62. (Original) The apparatus of claim 56, wherein said second acoustic signal has a substantially opposite phase compared to said first acoustic signal.

63. (Original) The apparatus of claim 56, wherein said nanowires are coated with a dielectric material to thereby form a gate dielectric.

64. (Original) The apparatus of claim 56, wherein said nanowires are N-doped.

65. (Original) The apparatus of claim 56, wherein said nanowires are P-doped.

66. (Original) An apparatus for providing acoustic cancellation, comprising:

a substrate;

a plurality of acoustic cancellation cells formed in an array on a surface of said substrate, each acoustic cancellation cell of said plurality of acoustic cancellation cells including:

an acoustic antenna that receives a first acoustic signal;

a processor that processes the received first acoustic signal, and generates a corresponding cancellation control signal; and

a transistor that includes a thin film of piezoelectric nanowires, wherein said thin film of piezoelectric nanowires is in electrical contact with a drain contact and a source contact of said transistor, wherein a gate contact of said transistor is coupled to said cancellation control signal;

wherein said thin film of piezoelectric nanowires outputs a second acoustic signal according to said cancellation control signal;

wherein said second acoustic signal substantially cancels said first acoustic signal.

67. (Original) A distributed sensor network, comprising:

a base station configured to manage the distributed sensor network; and

at least one sensor, said sensor coupled to said base station, said sensor fabricated from dense, inorganic and aligned nanowires.

68. (Original) A method for fabricating a dense, inorganic and oriented nanowire thin film transistor, comprising the steps of:

(1) synthesizing semiconductor nanowires;

(2) transferring the nanowires to a substrate;

(3) forming a dense monolayer thin-film with the nanowires substantially aligned in the same direction; and

(4) using standard semiconductor fabrication processes to form the dense, inorganic and aligned nanowire thin film transistor.